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CATEGORY I-IIIA MALES

by

James M. Lewis

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An Examination of the Influence of Environmental Factors on Recruiting Category I-IIIA Males

by

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Captain, United States Army
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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

This thesis studies the influence of environmental factors on recruiting Category I-IIIA males for the United States Army. Econometric modeling using regression analysis is used to estimate the determinants of the supply of recruits. Four models are developed from the cross-sectional time-series data and comparisons of the elasticities of the independent variables are given. The four models are Ordinary Least Squares, Instrumental Variable Estimation, Instrumental Variable Estimation with AR(1), and Fixed Effects. Following a discussion on how the data was collected over a four year period on a monthly basis for each of the Army's fifty-five recruiting battalions (except Puerto Rico), each model is specified and the possible violations of the basic assumptions of linear regression discussed. Results of each model are presented and interpreted in terms of resource allocation and policy implementation. Finally, fixed effects regional models for each recruiting brigade are run and geographical variation examined.

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I. INTRODUCTION

A. PURPOSE

The ability to attract qualified young men into the U.S. Army has been a major concern of Army manpower officials ever since the abolition of the draft in 1973. The primary focus in luring young adults into the Army has been through economic incentives. The Army has joined in competition with private corporations, universities, farms, small businesses, and industries for these young people. In the past 10 years, the Army has generally been able to obtain the number of individuals it required, but the quality of those recruits, as measured by high school completion and aptitude scores, has varied considerably. In 1979 for example, 16% of the individuals enlisting in the Army had high school diplomas, while in 1983 the figure was 39% [Ref. 1: p. 261].

With the advent of more sophisticated weapon systems and the systems which support them, a rising proportion of Army occupations require personnel with above average skills and extensive training. A higher quality enlisted force may also be more cost effective. A recent study has shown that there is a direct link between aptitude scores and job performance, as measured by skill tests, scores from training exercises, and promotion rates [Ref. 2]. In addition to being more likely to complete their first term of service, most Army officers agree on the basis of their experience with troop units that there are very great advantages to having bright troops.

Experience and research and study efforts have clearly shown that environmental factors, over which the Army and the Recruiting Command have little or no control, tend to dominate recruiting performance if timely action is not taken to compensate for downturns with resources and management initiatives. The single most important factor is the nation's economy and the closely related civilian employment opportunities. Also important is the military/civilian pay comparability. There is credible evidence indicating that national sentiment toward the military and patriotism also play a significant role in enlistment decisions.

Since 1980 when the Army recognized the need to improve the quality of its enlisted population, emphasis has been on recruiting high school diploma graduates (HSDG) who score in the upper half of the Armed Forces Qualification Test (AFQT). Candidates who achieve this type of score are classified as Category I-IIIA (Cat I-

IIIA). Recruiter experience, numerous studies, and common sense tell us that high quality recruits have more and better civilian employment and college-level education options and are therefore more difficult to recruit. As a result, eligibility for incentives such as the Army College Fund and cash enlistment bonuses have been limited to HSDG Cat I-IIIA recruits, and recruiter incentives have been established that provide greater reward for recruiting high quality youth. Research results indicate that recruitment of HSDG Cat I-IIIA youth takes about four times more recruiter effort than recruitment of less qualified people [Ref. 1: p. 261].

Military manpower supply under the all-recruited concept depends on the ability of the military to compete in the labor market on mostly economic terms in order to contract people for service in the military. The success of this is determined by enlistment decisions by individuals qualified for military service (influenced by enlistment offers and incentives) and the military recruiting system. The effort of this paper is to identify the factors that affect recruiting through demographic analyses, analyses of economic factors, and econometric modeling.

The U.S. Army Recruiting Command (USAREC) faces a tightening budget with increasing restrictions on bonus incentives offered to first-term enlistees, a shrinking advertising dollar, an improving economy, and a diminishing youth population. As these types of restrictions tighten, USAREC's ability to lure high quality (category I-IIIA) male recruits will become more dependent on those factors over which, as stated earlier, the Army has little control. The econometric model developed in this paper is an effort to assist the Army in determining better resource allocation, improving market segmentation,expanding recruiting markets to compensate for the declining youth market, and making more accurate forecasts of recruiting requirements.

B. BACKGROUND

Recruiting forecasting is done almost exclusively with econometric models, using various methods of regression analysis where enlistments is used as the dependent variable and factors that have been found to affect recruiting as independent (explanatory) variables.

The use of econometric models is well documented over the past decade of All-Volunteer Force (AVF) research [Ref. 3: p. 95]. Beginning with Professor Charles Brown's modeling effort on the behalf of the Army Research Institute in 1983, emphasis is being placed on time-series cross section (TSCS) models to assist Army manpower officials in conducting policy analysis and forecasting the recruiting effort.

These models can be roughly categorized as those used for resource allocation, which must include all the relevant resource policy variables, and for reliable forecasting of the recruit supply. In addition to Brown's model, other widely accepted TSCS models include Goldberg and Greenston's, and Daula and Smith's.

Brown's model analyzes the determinants of the supply of enlistees to the U.S. Army using quarterly data from the fourth quarter of fiscal year 1975 to the third quarter of fiscal year 1982 for the fifty states and the District of Columbia. In order to achieve an adequate sample size without including draft-period observations and to take advantage of large regional differences in the path of unemployment in recent years, pooled data were used. Brown's main conclusion is that unemployment rates have quite strong effects on recruitment success. For various categories of high quality recruits, the elasticity of contracts signed with respect to the unemployment rate ran from .4 to .8 [Ref. 4]. There was also consistent evidence that the number of contracts was inversely related to civilian wages. The dependent variable in Brown's model is the ratio of the number of contracts signed by male non-prior service Army enlistees to the enlistment-age population. Brown used 9 explanatory variables in an effort to specify the model. These variables attempted to capture the influence of military pay, civilian wages, unemployment, recruiting resources, and advertising.

Lawrence Goldberg and Peter Greenston's TSCS model analyzes the supply of nonprior service, male, upper mental category enlistments. Pooled data with annual observations from 1976 to 1983 was used. A clear distinction between this model and Brown's model is that, in addition to a different time series (annual vs. quarterly), a different cross section is used. Goldberg and Greenston's use of recruiting districts is an improvement to the state data used by Brown because recruiting districts overflow state boundaries and contracts signed are maintained at district level. Goldberg and Greenston's conclusions are that the determinants of enlistments are quite similar across the services. High quality enlistments increase with military pay, cyclical unemployment, regional unemployment, total high school senior and diploma graduate population, urban mix, and recruiters (per population) and they decline with black population and the loss of GI Bill benefits. [Ref. 3: p. 70]

Daula and Smith's TSCS model is the most sophisticated in its approach to determining the supply of high quality male recruits. This model distinguishes between the supply-constrained and the demand-constrained recruiting environments and uses a switching regression approach to model the problem. Brown and Goldberg's models

assumed a supply-constrained environment by using high quality recruits as the dependent variable. The assumption being made is that one is more likely to run out of high quality people before running out of slots to place them in. Daula's model tests this assumption prior to running the appropriate regression. Supply-constrained observations are used to estimate an enlistment supply function for male high quality recruits. Demand-constrained observations are used to estimate a separate model of enlistment production in demand-constrained environments. If demand-constrained observations were mistakenly used in a supply constrained environment or vice-versa, the resulting estimate of the elasticity of supply with respect to relative pay would be biased.

The same argument can be applied to the estimated parameter of the recruit supply function. Daula and Smith argue that if demand constraints exist, then a separate model of enlistments in the demand-constrained environment must be specified. The time series data used is monthly observations on Army recruiting battalions (cross-sectional units). In an attempt to avoid specification error, 19 explanatory variables are used to capture the environmental effects on recruiting high quality males. Daula and Smith's conclusions indicate that enlistments of a group usually considered to be supply constrained overall may be demand constrained if enlistment goals are set too low. This finding has several implications for the use of enlistments models in policy making [Ref. 3: p. 118].

C. OBJECTIVE

The effort in this paper is to fuse together the ideas of the previously mentioned models. A further development of a basic time series cross section model will be accomplished with new specification of commonly used independent variables and the inclusion of new explanatory variables that will eliminate omitted variable bias from previous work. Although Daula and Smith's model appears to be in the forefront of econometric modeling with regard to assisting Army manpower planners in policy formulation and enlistment forecasts, econometric forecasting is far from an exact science. USAREC currently uses four forecasting models for the purpose of contemplating the future recruiting needs of the Army [Ref. 5]. The current USAREC philosophy is to approach the recruiting problem from several different angles in order to place a range on the estimates of the determinants of the available recruit supply as well as the number of potential recruits expected. It is in this spirit that the model in this paper is developed.

A significant goal of this paper is to achieve the estimation of consistent structural parameters. Given the length of the Department of Defense budgeting process, shortfalls in recruiting must be identified more than a year before they are experienced. The requirement for reliable forecasting and accurate resource allocating is clearly evident.

In review, econometric modeling using mostly regression analysis will be used to help estimate the determinants of the recruit supply to help Army manpower officials determine resource allocation. Because of tightening environmental restrictions that affect recruiting and increasingly limited amounts of funds allocated by Congress to recruit with, the Army must make every dollar received for recruiting count.

The econometric model presented in this paper is an extension of previous work by accomplished econometricians. The model's goal is to assist the Army in determining better resource allocation through the identification of consistent structural parameters, improve market segmentation through the analysis of the geographical variation of the determinants of the recruit supply, and develop accurate forecasting of the supply of recruits through the application of the sound theory and practice of econometrics.

D. ORGANIZATION

This introduction is followed by four additional chapters. Chapter II details the data collection techniques and explains what each data set is, how it was collected, and why it is considered proper for the model. Chapter III specifies the model development. The functional form of the model and the interpretation of the coefficients will also be discussed. Chapter IV presents the results of the model to include its predictive ability, interpretation of geographical variation, and the structural analysis of the model's parameters. The final chapter, Chapter V, will give the conclusions.

II. DATA COLLECTION

A. INTRODUCTION

This chapter details the creation of the dependent variable and the explanatory variables that make up the database. Plausible explanations will be given to support the inclusion of these variables into the model. The procedure used to create the variables for the aggregate data enlistment model will be explained and specific definitions of each explanatory variable will be stated.

The enlistment model is estimated with a time-series cross-sectional data set that includes observations on 55 of the Army's 56 recruiting districts (battalions) by month from October 1980 to September 1984. This period covers 4 fiscal years and every recruiting battalion with the exception of Puerto Rico. Puerto Rico was not included because of significant missing data.

The data used in this model was collected from USAREC, Bureau of Labor Statistics (BLS), the Census Bureau, Department of Education (DOE), and the Defense Manpower Data Center (DMDC). Each time series (data set or variable) collected was maintained by one of these sources on a monthly basis. In the cases where the data were collected by either BLS or DOE the information is gathered and maintained at the county level. In the cases where the data were collected by either USAREC or DMDC information is maintained at the recruiting battalion level. In those instances where county information is used to create a variable, a transformation of the data is required. County level data were aggregated up to recruiting battalion level because enlistment statistics (the dependent variable) are maintained at battalion level and most allocation of resources is done at battalion level. This transformation is straight forward and valid because an Army recruiting battalion is made up of counties.

BLS and DOE maintained monthly information on a significant portion of United States counties. These statistics consisted of economic and demographic measurements. Counties not individually recorded by these agencies are lumped together and reported as rest-of-state data. Each state has a rest-of-state category. The proportion of a county's contribution to the battalion's total figure for each explanatory variable is determined by the percentage of the battalion's military youth population (age 17-21) that resides in that county. This percentage is multiplied by the

existing data point of that county or to the rest-of-state data point if BLS or DOE does not specify that county. The aggregation of all these counties within the battalion results in the data point for that particular battalion for any explanatory variable and any period.

B. DEPENDENT VARIABLE

The dependent variable in this regression model is the gross number of contracts signed by male high school seniors and graduates who have scored above average on the Armed Forces Qualification Test (AFQT). All potential enlistees take the Armed Services Vocational Aptitude Battery (ASVAB). The scores from four sections of that test that cover mathematical and verbal skills are combined to form the AFQT. Individuals with above average scores on the AFQT are in categories I-IIIA. The number of high quality enlistments is designated as supply constrained because the Army will take all of this type of individuals it can get. This is a significant requirement because interpretation of the enlistment supply model with other than supply constrained observations on the dependent variable will be inconsistent. Any effort to estimate the elasticity of the dependent variable with respect to the factors influencing it will be biased.

The enlistment contract data used to estimate the model come from the Defense Manpower Data Center. Their series reports the total number of contracts signed while the Army's records report total contracts signed minus youths who enrolled in the Army's Delayed Entry Program (DEP) and failed to show-up for induction. Since DEP loss is a conceptually different problem from enlistment, this study uses gross rather than net enlistment contracts.

Most studies of enlistments in the all-volunteer force have recognized that the observed number of enlistments is the minimum of the demand for new recruits and of their supply. The Army is neither pure price taker nor pure quantity taker. Rather, they attempt to fill a predetermined wage with recruit quality varying to equate supply and demand. Thus, the number of high quality enlistees is supply determined, but the total number of enlistees reflects both supply and demand forces. Figure 2.1 illustrates this point. Holding other factors constant, supply is drawn as a function of relative military compensation. Demand or the enlistment goal is determined by considerations of force size and structure in the short term. If the relative wage is W_1, demand exceeds supply and actual enlistments will be given by E_1. At W_2 military compensation is relatively more attractive, demand becomes the constraining factor, and enlistments

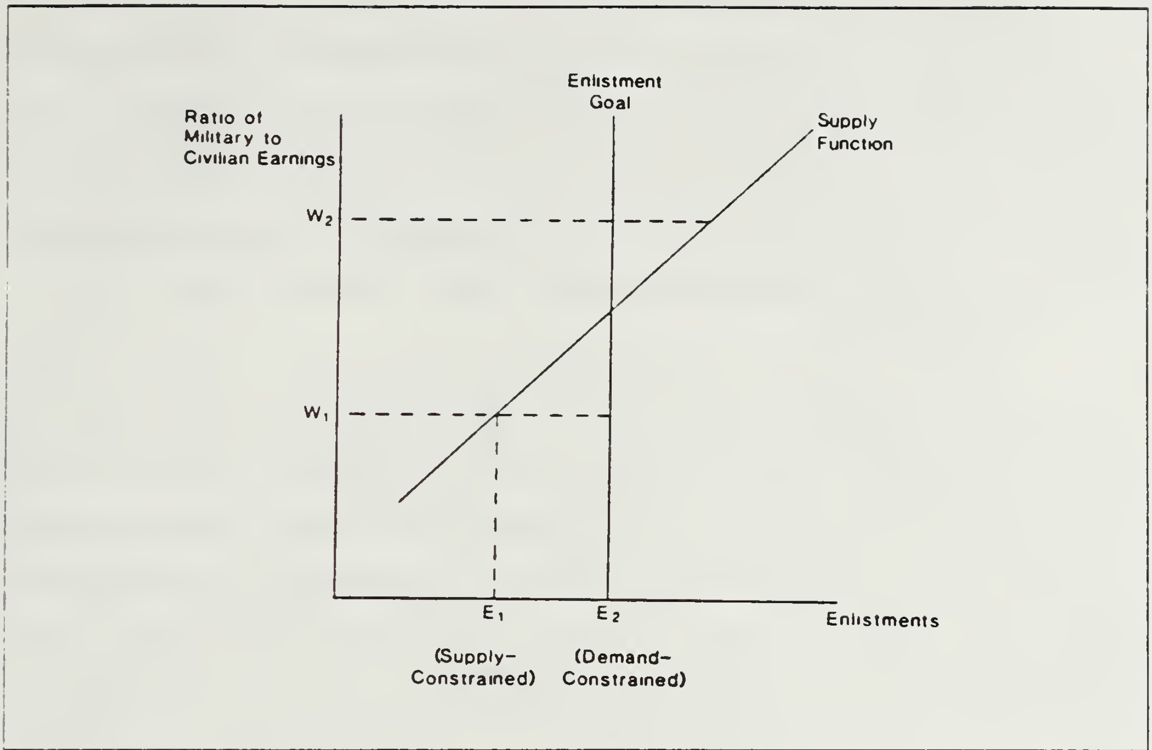

Figure 2.1 Supply vs Demand.

equal E_2. This model demonstrates a significant requirement in modeling the recruit supply. Only supply-constrained observations can be used to estimate enlistment supply of high-quality recruits. If demand-constrained observations were used, the resulting estimate of the elasticity of supply with respect to pay would be biased downwards. [Ref. 1: p. 263]

This study deals with the demand and supply constraints by restricting attention to specific groups of recruits accepted always by Army manpower officials as being in a supply-constrained situation. For the Army the always supply-constrained group is defined as "high-quality" males - high school graduates or seniors who score above average on the aptitude test administered before enlistment. This group is preferred by the Army because they are more likely to complete their first enlistment term and because they are more effective soldiers. In addition to being in higher demand, they also have better opportunities in the civilian sector, which reduces their supply to military employment.

C. INDEPENDENT VARIABLES

The data used in the specification of the enlistment model can be categorized into five broad areas: economic factors, sociodemographic factors, recruiting resources, enlistment policies, and enlistment competition. Each explanatory variable used in the construction of the enlistment model by association with one of the five above categories can be determined to be potentially significant in explaining or helping to describe the propensity of high-quality males to enlist in the U.S. Army.

1. Economic Factors

The most important set of parameters in the model, based on previous concerns by manpower officials, are those that measure economic factors. The attention these factors receive from both Army and Congressional manpower experts reflect important policy decisions and implementations. Previous literature indicates that military pay and unemployment received the most attention by econometricians trying to model the recruit supply [Ref. 6]. In analyzing the feasibility of the all-volunteer Army, the pay elasticity of enlistment was required to determine the budgetary cost of eliminating the draft. With the implementation of the all-volunteer Army, attention turned to the unemployment elasticity, because unemployment is the major uncontrollable factor affecting the proportion of high quality individuals that will enlist. Other significant economic factors that influence the enlistment decision of high-quality males is the enlistment bonus offered and civilian earnings opportunities available to the high-quality male. Bonuses may be thought of as interest free loans offered to the recruit. In lieu of monthly payments, a period of continuous service to the Army is expected. The idea of a lump sum of cash can be very appealing to many high school graduates. Most decisions a qualified youth makes in determining whether to enlist in the Army or not is weighted against the expected opportunities available in the civilian market. In essence the Army has to compete with these perceived opportunities and eventually, service to the nation must be more appealing than civilian employment in order for the high-quality male to enlist. Military pay, civilian earnings, unemployment, and enlistment bonuses are the significant economic factors that influence the number of high-quality males for service in the U.S. Army.

Ideally, an enlistment supply model would include a variable measuring the value of first-term military compensation compared with the expected civilian compensation for smarter-than-average male high school graduates. In practice, enlistment studies using a time series/cross sectional data set have typically included a

measure of first-term military pay and benefits, an estimate of full-time earnings for civilian workers, and the unemployment rate. This study follows the same specification.

The military compensation variable includes base pay, allowances for housing, and payments for meals (subsistence). Base pay is calculated for a 3-year enlistment, using the enlisted pay tables for the fiscal years in question and average rates of promotion through E-4. Allowances for each pay grade are evaluated as the weighted average of the allowances for single and married soldiers, using the proportions on enlisted personnel who are single and married within each pay grade as the weights. Allowances over the first term are then calculated from these averages using the promotion rates. Subsistence payments are added to the base pay and allowances to form basic military compensation. The other important component of first-term military compensation is the enlistment bonus, which is primarily used by the Army to attract recruits into job occupations that are otherwise unpopular, such as the combat arms. Because bonuses are occupation specific, it is very difficult to measure their impact in a model based upon aggregated data. However, to reflect changing levels of bonuses, the average bonus paid to high-quality individuals has been added into the the military pay variable.

Because the cross-sectional unit for this study is the Army recruiting district, unemployment rates for these areas were constructed from unemployment rates for Standard Metropolitan Statistical Areas (SMSA) and states. The unemployment data come from BLS. For each month an unemployment rate was assigned to every county in the United States. If the county was in an SMSA, that rate was used. Otherwise, a rest-of-state average was assigned. Unemployment rates for the recruiting battalions were formed as the weighted average of the rates for the counties in each battalion, using the proportion of the male 17-21 year-old population in the counties as the weights.

In most time series/cross sectional models of enlistment, the major weakness in the specification of relative pay is the measurement of civilian earnings opportunities. This study uses the average earnings of production workers in manufacturing. This differs from the conceptually desired variable in that it averages earnings of workers of all ages, rather than recent high school graduates, and is restricted to the manufacturing sector, which accounts for only about 25% of total U.S employment. A strength of this cross-sectional variable is that it allows for variance of earnings which do differ geographically.

The majority of new variables to be examined in this model that have not been used in previous models are classified as economic factors. Median family income and the number of people employed by major industry grouping hopefully captures the economic opportunities and career alternatives available to the qualified youth of a recruiting battalion. This information, maintained by BLS, and aggregated into a recruiting battalion average, could provide some dislinking from the sole use of unemployment rates to measure the susceptibility of youths to economic incentives provided by the Army.

2. **Sociodemographic Factors**

A variety of sociodemographic variables have been included in enlistment models to measure cross-sectional differences in the recruiting environment. The study and analysis of a battalion's demographics is critical to the allocation of resources. Previous studies have shown an underlying influence of a battalion's demographics in determining the supply of high quality recruits with respect to those factors that the Army has control of. Factors in the economic area like military pay and bonuses offered and implementation of an enlistment policy such as post education benefits if isolated from demographic considerations will cause a misallocation of resources to each recruiting battalion. The fact is that the offer of being an infantryman to a typical high school kid in Eureka, California is not perceived to be the same to the typical kid from Dayton, Ohio.

Perhaps the most important sociodemographic variable in an enlistment study with cross-sectional data is a measure of the population of potential high-quality recruits. That population will vary across recruiting districts both because the districts include different numbers of male youths and because the proportion of those youths that are high quality varies. For this study we have constructed a measure of the male high-quality population using population figures from 1982 and the proportions of that population that are high school graduates, score above average on the aptitude test, and are physically qualified, as estimated from the Youth National Longitudinal Survey (YNLS). In comparison with previous estimates of the potential population of high-quality recruits, this study uses a more recent source to determine the distribution of aptitude test scores in each recruiting battalion.

A variety of other sociodemographic variables have been included in enlistment models to measure cross-sectional differences in the recruiting environment. Included here are the proportion of the high-quality population that is minority, the

percentage of the presidential vote in 1980 for the Republican candidate, and quarterly dummies. Previous cross-sectional studies have usually found a negative coefficient on the minority variable. Although this may reflect a lower propensity for enlistment among minority youths, it is caused by unmeasured differences across regions that are correlated with the racial distribution [Ref. 1: p. 268]. The Republican vote variable is an attempt to measure differences in the strength of conservative or pro-military opinion. This is an attempt to find if the aversion to military service is on the decline. A recent survey of attitudes among Army officers and college students indicated that 1974-75 marked the beginning of a shift in American public opinion toward greater internationalism, support of defense, and concern about the Soviet Union [Ref. 7]. Finally dummy variables for fiscal quarters measure the seasonality in high-quality enlistments caused by the school year.

Using county data the total 17-21-year-old male population was determined for each recruiting district. This was multiplied by estimates of the proportion of that population that met the following criteria: were high school graduates or seniors, scored in mental categories I-IIIA on the AFQT, and reported no health problems that limited the kind or extent of jobs they could hold. The proportions for each district were estimated from the YNLS, which administered the AFQT to all respondents in the sample.

The minority proportion includes Blacks and youths with Hispanic surnames, and it was estimated for the high-quality population using the YNLS. The Republican vote in each recruiting district was constructed from SMSA and state data.

An additional sociodemographic variable included in this study that was not used in the previously mentioned models is the percentage of a recruiting battalion's population with college degrees. This information was provided by DOE and aggregated to the recruiting battalion level. This variable may measure future expectation of the military qualified youth in opposition to career opportunities provided by military service.

3. Recruiting Resources

The Army directly affects the supply of enlistments through the application of marketing resources, primarily recruiters and advertising. Recruiters provide information on the benefits of enlisting. This induces more individuals to consider a military career and more actually to choose to enlist over civilian alternatives. For this reason, it is expected that a recruiting district with more recruiters per population will

have more enlistments [Ref. 8]. Recruiters are analogous to salespeople. The more people you have on the street talking about the product, the more of the public will become aware and eventually greater numbers will be induced to join the Army. The main purposes of advertising are to stimulate goodwill, permit a "slick sales pitch" to the primary 17-21 year-old age group, and to improve attitudes toward military service among youth approaching and in the prime enlistable age and among their influencers [Ref. 9]. Advertising and recruiters frequently varied simultaneously and it is difficult to disentangle the independent effect of each. It is often unclear whether advertising affects sales or if the level of sales, whether high or low, affects the level of advertising, as both positions have historically been argued (e.g. "we need more advertising to maintain high sales" or "in markets with low sales, we need advertising to increase sales."). To answer questions about the cost effectiveness of both of these resource instruments - recruiters and advertising - they must be included in the enlistment supply function.

In terms of budgetary expenditures, the biggest recruiting resource is the recruiter force. There are approximately 5000 Army recruiters and the marginal cost of an additional recruiter is estimated to be about $35,000 [Ref. 1: p. 303]. To measure the impact of changes in the size of this force, the model includes the number of production recruiters assigned to each recruiting battalion, which is the number of recruiters actually involved in sales activities. Because it takes time for a newly assigned recruiter to know his territory, a measure of recruiter experience, the percentage of recruiters in each district with more than nine months there is included.

The effect of national advertising on enlistments, which is considered to be very important by recruiters, has been difficult to measure with any precision in enlistment supply models. In this study, national advertising will be measured in terms of gross impressions, the total number of times that an ad is seen by the target population. This measure has two conceptual advantages over advertising expenditures, the measure employed by almost all other studies. Depending on the nature of the advertising contract, an unusually large or small amount of impressions generated by a particular advertisement may or may not trigger a change in the cost of that ad. This means that changes in the amount of advertising delivered are not always reflected in changes in costs. Second, much of national advertising for recruiting is purchased through network buys. Although there is a single cost for these purchases, the actual impact in terms of impressions generated does vary across regions. The gross

impressions measure reflects network television and radio buys, national magazine advertisements, and spot advertisements - used to fill in where network coverage of the target group is not adequate - on radio and television.

The national advertising campaign measures only the Army advertising effort- the "Be All You Can Be" campaign. An interesting extension to the current specification included also in this model is the inclusion of impressions generated by joint service advertisements. Army recruiters argue that advertisements for all services are less effective in increasing Army enlistments.

There are, of course, other resources used in the recruiting process, such as cars, office space, and civilian clerical personnel. To the extent that other resources are allocated according to the number of recruiters, and many are, this estimate of recruiter effectiveness measures the impact of additional recruiters with their associated resources. It would, of course, be interesting to include other recruiting resources in an expanded version of the model. In addition, resources are not the only inputs to recruiting; students of successful sales operations would identify the quality of management as an important variable, for example. Because effects like these are difficult to measure, they have been omitted from this model. As there is no reason to believe that managerial effectiveness is correlated with the variables included in the model, this omission should not bias the remaining coefficients. [Ref. 1: p. 302]

4. Enlistment Policies

The Army also affects the supply of enlistments through the planning and implementation of enlistment policies which changes the characteristics of the military job by other means instead of earnings. The major policy options implemented by the Army to directly influence the Army's attractiveness to high quality 17-21 year-old males are the Army's postservice educational benefits program, changes in enlistment bonus amounts and coverage, and variation in the length of the first-term commitment. More high school graduates are now weighing post-graduation decisions on long-term expected gains and benefits instead of immediate future needs. The Army is realizing that in order to attract the high quality recruit needed to man today's complicated weapon systems, etc., the future most hold the expectation of improvement as well as advancement. Today's high school graduate looks not only at what he could be today - a private in the Army or a short order cook at McDonalds - but what he will also be in the in three or four years given a decision is made today - a corporal in the Army or an assistant manager at McDonalds. It is these policy options that the Army implements-

education benefits, enlistment bonus coverage, and variation in the length of service required upon enlistment that determine the endpoint of one's service to his country. Often it is the comparison of endpoints with respect to possible career paths that determine the job choice of the 17-21 year-old male. It is these policy options that determine a recruit's decision to enlist in the U.S. Army.

Because it is difficult to quantify changes in the nonpay characteristics of a military job, it is hard to estimate from historical experience the effects of these changes on high-quality enlistments. For this reason, recruiting experiments have been run recently to test variations in the most important of these incentives, postservice educational benefits and enlistment bonuses. During fiscal year 1981 all the services participated in a program that systematically varied the kind of education benefits program that could be offered in different recruiting districts. Starting in fiscal year 1982 there was a similar test, conducted by the Army only, which varied the size of enlistment bonuses and the length of the enlistment required to receive them. To measure the net impact of these program variations, dummy variables representing the treatments in both tests are included in the enlistment supply function.

During the period of 1981-1984 the Army had at various times one of four post service educational plans in effect. The four plans in effect were the Veterans Education Assistance Program (VEAP), Super VEAP, the Army College Fund, and the Mini GI Bill. Their effect on the enlistment supply function is allowed by the use of dummy variables.

Dummy indicator variables are also use to demonstrate the effect at each recruiting district during the period of this study. A control program or either a maximum of $8000 bonus for a four year enlistment or $8000 plus $4000 for a three year enlistment was used by each recruiting battalion during the period. These bonus programs alternated between all battalions.

5. Enlistment Competition

The fifth major category of variable type in the enlistment supply function is enlistment competition. There are two different kinds of competition in the recruiting process. The first is the competition between the services for male high-quality enlistments. There are no published estimates of the impact of other service enlistments on the Army, but it is commonly acknowledged that the Army is the service of last resort for high-quality individuals [Ref. 3: p. 2]. The Air Force and Navy both offer proportionately more occupational training opportunities than the Army and are

perceived to provide better living conditions for their enlisted personnel. This, of course, means that increased enlistments in the other services should reduce enlistment supply to the Army.

Previous studies have pointed out that there is intra-Army competition for the recruiter's time and effort [Ref. 10]. In addition to enlisting high-quality recruits, recruiters have an enlistment goal for all other individuals. Because these youths are demand constrained, meeting this goal is easier than meeting the goal of high-quality youths, but it is still a time-consuming process. This means, all other things equal, the more demand-constrained enlistments a recruiter is required to process, the smaller will be his output of high-quality enlistments.

Given these considerations, the model includes the number of male high-quality enlistments signed by the other services and the number of demand-constrained enlistments written for the Army. The data on all the other services contracts signed were obtained from DMDC. Since none of the four services have exactly the same boundaries on their recruiting districts, transformation of the data was required to allow the proper fitting of the data to each Army recruiting battalion. Percentages of common counties to recruiting battalions were used as the weighted averages to permit the aggregation of other services contracts into a data point which reflected the number of other services contracts signed within an Army recruiting battalion.

D. CONCLUSIONS

Although the enlistment decision process is complex, not entirely logically and rationally explainable, and varies greatly from person to person, the data used to run the model capture several accepted generalizations. Economic factors tend to dominate, particularly real and perceived difficulty of finding civilian employment, and real or expected civilian/military differences in emoluments, such as pay, benefits, and various enlistment incentives. The national sentiment towards country, patriotism, and military service is shifting. Service in the Army is gaining increasing acceptance as a feasible alternative to a civilian job or as a hiatus from additional education. In the last few years there has been a significant increase in the resources available for Army recruiting, and greater effectiveness in the use of these resources. Competition among services for the high-quality male exists. As the size of the potential pool of qualified youths shrinks into the 1990's, this competition must be addressed by the Army in order to insure that they attract their fair share of these youths.

The selection of these variables for the enlistment supply function hopefully captures a majority of the factors that influences the high-quality male to enlist. By eliminating omitted variable bias, the enlistment supply function specified by the model presented in this paper can support the Army in determining the best allocation of their recruiting resources to guarantee that the enlistment goal is met.

III. MODEL SPECIFICATION

A. INTRODUCTION

Modeling of the recruiting process is done almost exclusively with econometric models using various methods of regression analysis where enlistments is used as the dependent variable and factors that have been found to affect recruiting as independent variables. The regression equation developed permits forecasting of future recruits. The coefficients assigned to each independent variable in the equation allows analysis of the inter-relationships among the variables and each variable's influence on the recruiting process. The influence of variables on recruiting play a major role in the decisions made by Army manpower officials in determining budget requests from Congress and the allocation of resources to recruiting districts. The technique of regression analysis used in this study will be discussed in this chapter. This chapter will detail the step-by-step approach used to develop regression models that explain the relationship between the factors that affect recruiting and the number of high-quality recruits the Army attracts each month.

While the analysis of the models' results will be discussed in a later chapter, the specification of each model will be explained here and the results presented. The specification of the regression model based on the data available for input drives the step-by-step procedure. An explanation will be given on the validity of the basic assumptions of the so-called "classical normal linear regression model" as the models in this study are developed.

Following this brief introduction of the chapter, there will be a section describing the theory of linear regression. Afterwards, the ordinary least squares model with logarithmic transformation, the instrumental variable model, the instrumental variable with autocorrelation model, and the fixed effects model with geographical variation will be discussed.

B. THE REGRESSION MODEL

Regression analysis attempts to capture the behavior of a random variable (the dependent variable) through its assumed relationship with one or more additional random variables (the independent variables). This stochastic relationship between the dependent variable and the independent variables is described in a functional form known as a regression model:

$$Y_i = \alpha + \beta X_i + \varepsilon_i \qquad \text{(eqn 3.1)}$$

where Y is the dependent variable, X represents the independent variables, α and β the unknown regression parameters, and ε the stochastic disturbance. Observations on Y and X are observable but those of ε are not. When observations on Y and X are made over time and geographical areas, as in this study, they are commonly referred to as "pooled time-series and cross-section data". The model estimates the regression parameters, α and β, which permits the forecasting of Y given a set of X values and the analysis of each independent variable's influence on the dependent variable. The validity of the regression parameters is based on the assumptions of the stochastic disturbance, ε. The dependent variable depends not only on the values of the independent variables but also on a large number of random causes, which is aggregated in the form of the stochastic disturbance. Individually these causes are too insignificant to note, but their collective influence may be quite perceptible. Therefore the stochastic nature of the regression model implies for a given set of X values there is a probability distribution of Y values because of the presence of the disturbance value ε. The full specification of the regression model includes not only equation 3.1 but a set of basic assumptions [Ref. 11: p. 208]. These assumptions are:

- Normality: ε_i is normally distributed.
- Zero Mean: $E(\varepsilon_i) = 0$
- Homoskedasticity: $Var(\varepsilon_i) = \sigma^2$.
- Nonautocorrelation: $Cov(\varepsilon_i, \varepsilon_j) = 0$
- Nonstochastic X: X is a nonstochastic variable with fixed values in repeated samples.

In modeling the recruiting phenomena, the classical normal linear regression model is characterized by the possible violation of two of these assumptions, homoskedasticity and nonautocorrelation. Awareness of any violation of these assumptions is critical if one is attempting to accurately portray the relationship among environmental factors and recruiting. The estimated coefficients developed under the violation of homoskedasticity and nonautocorrelation will be biased, inconsistent, and inefficient. Coefficients having these difficiencies will cause misallocation of recruiting resources and inaccurate forecasts. The ramification of these deeds are clearly evident.

The estimates of an unknown parameter, in this case, the coefficients of the explanatory variables, are statistics, random variables whose value can be observed on the basis of a sample. Since these random variables in the regression model will measure the influence of the environmental factors on recruiting and thus become leading indicators for determining effective policy implementation and resource allocation, it is critical that these estimators possess the properties of unbiasedness, efficiency, and consistency.

An unbiased estimator is a random variable whose expected value is the parameter being estimated. If the estimator is unbiased, and repeated samples of size n were taken, the average of these observed values would be the parameter being estimated. If an estimator is biased, the actual value of the parameter will be over or under estimated.

The efficiency of an estimator measures the variance associated with the expected value of the parameter. An efficient estimator guarantees the minimum variance possible while inefficiency signals that the minimum variance has not been attained. Because variance is the average squared distance between a random variable and its mean, minimizing it permits confidence in the relationship modeled between the explanatory variables and the dependent variable.

The final critical property an estimator should possess is consistency. Consistency means that both the variance and bias go to 0 as the number of observations on the observed values go to infinity. The effort in this study is to achieve consistent estimators of the actual coefficients in the enlistment supply equation.

C. ORDINARY LEAST SQUARES

The first model developed in this study is the most frequently used estimating technique - ordinary least squares (OLS). The least squares principle for choosing the estimators of the coefficients is to minimize the sum of the squared residuals or the sum of squared deviations of the observed values from their mean. Under the basic assumptions discussed previously, the estimators obtained in this model are unbiased, consistent, and efficient. These properties are critical if anyone uses the model for policy determination, resource allocation, or forecasting.

The acceptance of the OLS technique in this study is made difficult because of the nature of the data. Estimation of relationships that combine time series and cross-sectional data often involves problems with autocorrelation and heteroskedasticity. OLS estimators developed under the presence of either of these conditions are unbiased

but inefficient. Before anyone totally disregards the OLS technique when attempting to model pooled data, a substantial amount of econometric modeling in recruiting continues to use OLS. Goldberg and Greenston's model is developed with OLS techniques and Brown offers a comparison of the OLS technique with the generalized least squares (GLS) method Brown makes this comment concerning OLS and GLS:

> "OLS underestimates the standard errors of coefficients in the presence of serial correlation, but in these data the standard errors changed little when GLS was used. GLS also provides smaller true standard errors when the serial correlation coefficient is known, but this gain does not necessarily occur when the correlation is estimated." [Ref. 4: p. 27]

In most cases the serial correlation coefficient, ρ, will be estimated. The simple way of estimating ρ is to replace the ε's in $\varepsilon_t = \rho\varepsilon_{t-1} + \mu_t$ by the corresponding least squares residuals. The least squares estimator of ρ from $e_t = \rho e_{t-1} + \mu_t$ is given as:

$$\rho = \frac{\Sigma e_t e_{t-1}}{\Sigma e^2_{t-1}} \quad (t=2,3,\ldots,n). \qquad \text{(eqn 3.2)}$$

[Ref. 11: p. 315].

While OLS estimation may be incorrect from a theoretical point of view, it may offer correct interpretation of variable relationship. The best way to determine if OLS is correct or not is to do what many researchers do, run several models and compare the results. This is what this paper does. The hypothesized model using the OLS technique in this study is:

$$\ln Y = \alpha + \beta \ln X + \mu \qquad \text{(eqn 3.3)}$$

where Y is the number of high-quality male recruits, X is the set of explanatory variables which are assumed to affect recruiting and μ measures the randomness of Y caused by the omission of unknown variables that may have an impact on the value of Y. The estimated coefficients which are to be examined in this study, b, are derived from the equation:

$$b = (X'X)^{-1}X'Y \qquad \text{(eqn 3.4)}$$

Natural logarithms were used to eliminate the potential problem of heteroskedasticity. The logarithmic transformation of the data permits the coefficients to be interpreted directly as percentage changes in the recruit supply as the environmental factors vary. A logarithmic transformation is preferable on both Y and X to linearize the relation and cause the slope of the regression line for the transformed variables to measure the elasticity of the X variables. The test used for evaluating the presence of heteroskedasticity in the data is the Breusch Pagan test. Heteroskedasticity is often present in cross-sectional data and data transformation (use of natural logarithms) is a common practice used to correct for it. The technique of grouping data (aggregating county statistics) to form an observation gives further credence to the suspicion of heteroskedasticity in the data set [Ref. 11: p. 368].

Breusch and Pagan test for heteroskedasticity by comparing the value of one half of the explained sum of squares (Q) to the chi-square statistic (χ^2) at the .95 level with 2612 degrees of freedom. The claim that the variance among error terms is constant, i.e., homoskedasticity is present, is valid if Q is less than χ^2. The value for Q in the OLS model is 197.68. The χ^2 is determined by the normal approximation because the size of the sample 2640 is greater than 30. The χ^2 in the OLS model is 2697. The results confirm that the transformed data is homoskedastic, or of constant variance. The results of using ordinary least squares estimation are displayed in Table 1.

D. INSTRUMENTAL VARIABLE ESTIMATION

Like Goldberg and Greenston's and Brown's models, Daula and Smith's research in recruit modeling with pooled data indicated that the OLS technique did not perform badly in prediction tests [Ref. 1: p. 299]. Their hypothesis for the OLS model's unexpected performance is that the data included in the OLS model omitted two key variables which had a counteracting effect- the interservice competition and the enlistment goal. Those variables, used by Daula, are also included in this study.

If ordinary least squares estimates are applied with the inclusion of these competition effects in the explanatory variable set, the estimates of the parameters are subject to bias and inconsistency because the variables used to measure competition effects may have errors in their measurement. Since these competition effects may affect Army high-quality enlistments, instrumental variable estimation was used to avoid specifying enlistment functions for all the services. The dependent variable in this model, the number of CAT I-IIIA males recruited, is predicated on the fact that

TABLE 1

ORDINARY LEAST SQUARES ESTIMATION

Explanatory Variables	Estimates	Explanatory Variables	Estimates
Constant	-4.49 (.409)	Maximum 8k Bonus	.143 (.023)
Military Pay	.491 (.057)	Control Cell	.185 (.185)
Unemployment	.432 (.028)	Nat'l Adv	.059 (.059)
Recruiters Assigned	.556 (.039)	College Degrees	-.203 (.060)
Urban Pop	.053 (.013)	Income	.826 (.093)
Recruiter Exp	-.023 (.033)	% Black	-.078 (.009)
Local Advertising	.015 (.012)	% Hispanic	-.103 (.007)
Second Qtr	.146 (.015)	Construction	.130 (.033)
Third Qtr	.116 (.015)	Trans and Util	-.632 (.042)
Fourth Qtr	.278 (.015)	Retail Trade	.589 (.090)
Army College Fund	.275 (.019)	Finance/Insurance	.052 (.048)
Noncontributory VEAP	-.030 (.030)	Services	-.079 (.054)
Mini GI Bill	.022 (.031)	Government	.176 (.040)
8K Plus 4 Bonus	.293 (.023)	Manufacturing	-.011 (.021)
		High Quality Goal	.324 (.028)
Qualified Military Available	-.031 (.027)	1980 Vote	.034 (.065)
		Standard Error of Regression	.254

Standard error is in parenthesis.

they are supply constrained. In addition to enlisting high-quality recruits, recruiters have an enlistment goal for all other individuals. While the rest of these recruits are demand constrained and therefore easier to recruit, they still take-up the recruiters' time. The more demand constrained enlistments a recruiter is required to process, the

fewer high-quality enlistments will be obtained. Therefore to measure this competition effect, the model includes the number of male high-quality enlistments written for the Army.

The significant problem caused by the inclusion of these "competition effects" variables in the ordinary least squares approach is the measurement error in the explanatory variables. These measurement errors in the explanatory variable cause bias and inconsistency in the estimators. To develop unbiased and consistent estimators when there are measurement errors in X, additional variables which are related to the true value of X but not with the errors of measurement are used [Ref. 11: p. 216]. These additional variables are called "instruments" because they are instrumental in letting one obtain consistent unbiased estimators of the regression parameters.

The corrected equation for determining the coefficients of the explanatory variables when instrumental variables are used to correct for error measurements in X is:

$$b = (W'X)^{-1}W'Y \qquad \text{(eqn 3.5)}$$

where W represents the matrix of instruments.

Table 2 provides the results of instrumental variable estimation with competition effects. The explanatory variables in this model which are suspected of having measurement errors are Army Cat I-IIIA non-high school graduate contracts,all other Army contracts, and other Department of Defense male high-quality enlistments. These variables' instruments are the respective enlistment goals for the different Army contracts and the number of other services' recruiters assigned in each Army recruiting battalion. The choice of the instruments is determined by its relationship with X and displays a high correlation with X. The range of their correlation coefficients is from .71 to .83.

E. AUTOCORRELATION

The models mentioned previously have been corrected for heteroskedasticity (by log transformation of variables), and possible error measurements in the explanatory variables (by use of instrumental variables). These basic regression models considered so far have assumed that the random error terms ε_i, are uncorrelated random variables. For time series data the assumption of uncorrelated error terms is often not appropriate. Much like the problems heteroskedasticity can cause when present in

TABLE 2

INSTRUMENTAL VARIABLE ESTIMATION WITH COMPETITION EFFECTS

Explanatory Variables	Estimates	Explanatory Variables	Estimates
Constant	-3.39 (.465)	Maximum 8k Bonus	.035 (.029)
Military Pay	.382 (.066)	Control Cell	.001 (.034)
Unemployment	.484 (.040)	Nat'l Adv	.074 (.009)
Recruiters Assigned	.364 (.057)	College Degrees	-.154 (.075)
Urban Pop	.021 (.031)	Income	.625 (.098)
Recruiter Exp	-.034 (.034)	% Black	-.104 (.026)
Local Advertising	.001 (.013)	% Hispanic	-.080 (.009)
Second Qtr	.093 (.093)	Construction	.210 (.064)
Third Qtr	.061 (.017)	Trans and Util	-.492 (.053)
Fourth Qtr	.258 (.036)	Retail Trade	.318 (.115)
Army College Fund	.236 (.032)	Finance/Insurance	-.009 (.051)
Noncontributory VEAP	.038 (.033)	Services	.073 (.083)
Mini GI Bill	.072 (.032)	Government	.205 (.063)
8K Plus 4 Bonus	.096 (.037)	Manufacturing	.043 (.045)
Qualified Military Available	.014 (.031)	High Quality Goal	.292 (.024)
Other I-IIIA	.060 (.021)	1980 Vote	.082 (.069)
All Other Army	.076 (.021)	Other DOD I-IIIA	-.349 (.097)
		Standard Error of Regression	.260

Standard error is in parenthesis.

cross-sectional data, autocorrelation when present in time series data, causes the least squares regression coefficients to no longer have minimum variance and may be quite inefficient.

Correlated error terms in the explanatory variables is suspect because of the monthly observations on each independent variable [Ref. 11: p. 299]. The assumption made in this study is that the regression disturbance follows a first-order autoregressive scheme, abbreviated AR(1). In the presence of AR(1) the basic assumptions that each error term represents a sampling from a normal distribution is violated. When the disturbances are first order autoregressive, the error terms are no longer independent normal but are generated according to the following scheme: $\varepsilon = \rho\varepsilon_{t-1} + \mu_t$. Credence to the susceptibility of autocorrelation in the model is substantiated by the Durbin Watson statistic (DW). The Durbin-Watson test measures the serial correlation, ρ , specifically AR(1), in least squares regression. The DW is computed from the vector of OLS residuals defined as: $e = Y - Xb$. If the error terms are positively autocorrelated, $\rho > 0$, the first differences in the error terms will be numerically smaller than the residuals themselves. The computed DW from the OLS residuals is compared to table values that have an lower and upper bound based on a 5% significance level, number of independent variables, and the number of observations. If the computed DW is less than the lower bound table value, AR(1) is present. If the computed DW is greater than the upper bound table value, there is no autocorrelation. DW values that fall between the upper and lower bound table values prove inconclusive. The OLS model has a DW of .806 while the instrumental variable model has a DW of .912. These values compare to a lower bound table value of approximately 1.81. A summary of the Durbin Watson test results for all the enlistment models are presented in Tables 3 and 5.

TABLE 3

DURBIN WATSON TEST

Model	DW Value	Table Value	Conclusion
OLS	.806	1.81	$\rho > 0$
INST VAR	.912	1.81	$\rho > 0$
OLS FIX	1.46	1.81	$\rho > 0$
INST VAR (AR1)	2.31	1.74	$\rho > 0$

The Cochrane-Orcutt procedure is used to obtain efficient estimates of the parameters of the enlistment supply function model where the regression disturbances

display first order serial correlation [Ref. 12]. This method estimates ρ from the OLS residuals, transforms the dependent and independent variables so that the residuals from the transformed equation will be roughly serially correlated, and then runs a regression using the transformed variables. This process is repeated until ρ converges or maximum number of iterations is reached. This technique is used in estimating with a pooled time series cross section sample by creating artificial gaps so that one region's variable is not used as a lagged value for the next region [Ref. 13].

In constructing the first-order autoregressive instrumental variable model, data restrictions were imposed by the Time Series Processor (TSP) computer package used to run the regression. Because of the number of data observations (2640) per variable there was a ceiling of 22 explanatory variables to be used. The variables included in this model were those that were found to statistically significant from the instrumental variable model. Variables are termed statistically significant if their estimated coefficient value is different from 0. Table 4 presents the results of this model.

F. FIXED EFFECTS

Another model that is commonly used when dealing with pooled cross-section and time series observation is the fixed effects model [Ref. 11: p. 630]. The fixed effects model allows for variation of the intercept term for each cross-section unit (in this case a recruiting district) but retains a common vector of slope coefficients for each unit. This model allows the analyst to examine the influence of the explanatory variables with each recruiting battalion's own environmental factors removed. In other words, resource bias, such as larger population, lower unemployment, more recruiters assigned, etc., is removed from the parameter estimation and a more strict interpretation of the coefficients is permitted.

The fixed effects model is generally treated within the framework of the classical linear regression model or OLS [Ref. 11: p. 630]. The disturbance, ε, is supposed to satisfy the basic assumptions of the classical normal linear regression model. The regression equation for the fixed effects model is :

$$Y = \alpha_i Z_i + \dots \alpha_n Z_n + \beta X + \varepsilon \qquad \text{(eqn 3.6)}$$

where Z_i equals 1 for the ith unit or 0 otherwise.

Table 6 gives the results of the fixed effects model with ordinary least squares estimation. The Durbin-Watson statistic of 1.46 suggest that positive autocorrelation is

TABLE 4

INSTRUMENTAL VARIABLE ESTIMATION WITH AR(1)

Explanatory Variables	Estimates	Explanatory Variables	Estimates
Constant	-2.18 (.656)	High Quality Goal	.211 (.019)
Military Pay	.282 (.063)	Income	.386 (.150)
Unemployment	.471 (.040)	Nat'l Adv	.051 (.007)
Recruiters Assigned	.393 (.056)	College Degrees	.001 (.096)
% Hispanic	-.068 (.011)	% Black	-.084 (.014)
Second Qtr	.069 (.017)	Construction	.252 (.048)
Third Qtr	.040 (.018)	Trans and Util	-.268 (.052)
Fourth Qtr	.183 (.019)	1980 Vote	-.039 (.112)
Army College Fund	.202 (.028)	Government	.204 (.066)
Other Army Contracts	.128 (.046)	Other I-IIIA	-.008 (.021)
Qualified Military Available	.002 (.043)	Other DoD I-IIIA	-.044 (.038)
		Standard Error of Regression	.196

Standard error is in parenthesis.

TABLE 5

DURBIN WATSON TEST (FIXED EFFECTS)

Region	DW Value	Table Value	Conclusion
Northeast	2.09	1.79	$\rho = 0$
Southeast	2.06	1.79	$\rho = 0$
Southwest	2.02	1.79	$\rho = 0$
Midwest	2.05	1.79	$\rho = 0$
West	2.06	1.79	$\rho = 0$

present. To correct for this, ρ was estimated. Because of the memory limitations on TSP, no Army-wide fixed effects model with AR(1) could be estimated. Five fixed effect models with AR(1) were estimated, one model for each recruiting region (Tables 7-10). The DW for these models ranged from 2.02 to 2.09. These tests suggest that no autocorrelation is present and the estimation of the coefficients are unbiased, consistent, and efficient. These fixed effects model could not be estimated with instrumental variables in TSP. This required the omission of competition effects from the model. Using the fixed effects models for analysis one must be aware of potential omitted variable bias.

Running the fixed effects models at the regional level still offers a valuable analytical tool for studying the effectiveness of resource allocation. The regional fixed effects models make comparison with Army-wide models more difficult, but are still useful in examining the variation of environmental factors caused by geographical differences.

G. CONCLUSIONS

One of the primary goals of an econometric model is to estimate relationships. In terms of the recruiting process, these estimated relationships among variables develop into resource allocations. Adequate support of Army recruiting is essential for continued success in meeting manpower goals. In order to insure this success, reliable relationships must be estimated. This chapter discussed the requirements, i.e. the basic assumptions that must be adhered to, to guarantee parameter coefficients that are unbiased, consistent, and efficient.

A myriad of models were specified. Each model corrected for a potential violation of one of the basic assumptions of the linear regression model. The results of these models are presented here to highlight the variation of estimates one receives when a model's specification is adjusted. No one, final, appropriate model is offered because like most of the data (based on economic forecasts) fed into these models, each of these models is subject to error. By specifying several models, a range of possible results are presented that allow the officials who allocate resources flexibility in their planning and issuance of them.

TABLE 6

ORDINARY LEAST SQUARES ESTIMATION WITH FIXED EFFECTS

Explanatory Variables	Estimates	Explanatory Variables	Estimates
Military Pay	.237 (.077)	Control Cell	.047 (.025)
Unemployment	.237 (.077)	Nat'l Adv	.054 (.007)
Recruiters Assigned	.150 (.054)	College Degrees	-.413 (.096)
Urban Pop	.135 (.048)	Income	.488 (.077)
Recruiter Exp	-.019 (.027)	% Black	-.183 (.031)
Local Advertising	-.017 (.010)	% Hispanic	-.109 (.017)
Second Qtr	.075 (.015)	Construction	-.004 (.061)
Third Qtr	.073 (.015)	Trans and Util	-.231 (.168)
Fourth Qtr	.234 (.014)	Retail Trade	.175 (.250)
Army College Fund	.203 (.018)	Finance/Insurance	.183 (.221)
Noncontributory VEAP	-.057 (.025)	Services	.209 (.221)
Mini GI Bill	-.003 (.026)	Government	-.351 (.141)
8K Plus 4 Bonus	.049 (.025)	Manufacturing	-.252 (.117)
Qualified Military Available	-.021 (.017)	High Quality Goal	.087 (.016)
1980 Vote	.001 (.069)	Maximum 8K Bonus	.016 (.019)
		Standard Error of Regression	.194

Standard error is in parenthesis.

TABLE 7

FIXED EFFECTS MODEL NORTHEASTERN REGION

Explanatory Variables	Estimates	Explanatory Variables	Estimates
Military Pay	.316 (.161)	Control Cell	.172 (.039)
Unemployment	.647 (.076)	Nat'l Adv	.055 (.013)
Recruiters Assigned	.336 (.101)	College Degrees	.867 (.218)
Urban Pop	.378 (.216)	Income	1.49 (1.60)
Recruiter Exp	-.037 (.067)	% Black	-.288 (.176)
Local Advertising	-.009 (.025)	% Hispanic	-.369 (.082)
Second Qtr	-.010 (.039)	Construction	-.294 (.181)
Third Qtr	-.030 (.028)	Trans and Util	-.285 (.220)
Fourth Qtr	.182 (.299)	Retail Trade	-.495 (.558)
Army College Fund	.172 (.038)	Finance/Insurance	.439 (.238)
Noncontributory VEAP	-.021 (.030)	Services	.876 (.429)
Mini GI Bill	.141 (.065)	Government	.406 (.249)
8K Plus 4 Bonus	.116 (.074)	Manufacturing	.114 (.256)
Maximum 8K Bonus	.151 (.563)	High Quality Goal	.110 (.032)
Qualified Military Available	.946 (.456)	1980 Vote	1.82 (.837)
		Standard Error of Regression	.174

Standard error is in parenthesis.

TABLE 8

FIXED EFFECTS MODEL SOUTHEASTERN REGION

Explanatory Variables	Estimates	Explanatory Variables	Estimates
Military Pay	.241 (.193)	Control Cell	.129 (.059)
Unemployment	.617 (.132)	Nat'l Adv	.071 (.016)
Recruiters Assigned	-.087 (.170)	College Degrees	-5.97 (1.23)
Urban Pop	.543 (.196)	Income	5.26 (1.20)
Recruiter Exp	.115 (.099)	% Black	1.44 (.305)
Local Advertising	.129 (.038)	% Hispanic	-.052 (.025)
Second Qtr	.022 (.041)	Construction	-.196 (.276)
Third Qtr	.059 (.038)	Trans and Util	-1.58 (.441)
Fourth Qtr	.274 (.039)	Retail Trade	1.74 (.838)
Army College Fund	.244 (.054)	Finance/Insurance	1.49 (.651)
Noncontributory VEAP	-.040 (.067)	Services	-.887 (.557)
Mini GI Bill	-.041 (.078)	Government	.819 (.198)
8K Plus 4 Bonus	.306 (.076)	Manufacturing	-.379 (.206)
Maximum 8K Bonus	.001 (.076)	High Quality Goal	.119 (.052)
Qualified Military Available	2.75 (.617)	1980 Vote	-1.02 (.632)
		Standard Error of Regression	.206

Standard error is in parenthesis.

TABLE 9

FIXED EFFECTS MODEL SOUTHWESTERN REGION

Explanatory Variables	Estimates	Explanatory Variables	Estimates
Military Pay	.271 (.191)	Control Cell	.038 (.058)
Unemployment	.763 (.082)	Nat'l Adv	.062 (.014)
Recruiters Assigned	.202 (.161)	College Degrees	-2.70 (2.10)
Urban Pop	.410 (.229)	Income	2.34 (2.82)
Recruiter Exp	.150 (.079)	% Black	-.725 (.287)
Local Advertising	.008 (.029)	% Hispanic	-.137 (.084)
Second Qtr	.044 (.038)	Construction	-.473 (.243)
Third Qtr	.026 (.037)	Trans and Util	-.348 (.415)
Fourth Qtr	.057 (.038)	Retail Trade	1.01 (.975)
Army College Fund	.120 (.056)	Finance/Insurance	.012 (.423)
Noncontributory VEAP	.022 (.060)	Services	2.05 (.423)
Mini GI Bill	.002 (.059)	Government	-1.39 (.309)
8K Plus 4 Bonus	.067 (.057)	Manufacturing	-.005 (.285)
Maximum 8K Bonus	.116 (.070)	High Quality Goal	.087 (.036)
Qualified Military Available	-.106 (.360)	1980 Vote	-1.99 (1.71)
		Standard Error of Regression	.188

Standard error is in parenthesis.

TABLE 10

FIXED EFFECTS MODEL MIDWESTERN REGION

Explanatory Variables	Estimates	Explanatory Variables	Estimates
Military Pay	-.016 (.117)	Control Cell	-.049 (.040)
Unemployment	.923 (.080)	Nat'l Adv	.056 (.012)
Recruiters Assigned	.589 (.130)	College Degrees	.239 (.351)
Urban Pop	-.071 (.195)	Income	.120 (.547)
Recruiter Exp	-.040 (.053)	% Black	-.247 (.078)
Local Advertising	-.037 (.027)	% Hispanic	-.121 (.055)
Second Qtr	.069 (.042)	Construction	.339 (.142)
Third Qtr	.059 (.031)	Trans and Util	-.283 (.297)
Fourth Qtr	.215 (.029)	Retail Trade	-.768 (.499)
Army College Fund	.158 (.042)	Finance/Insurance	.107 (.339)
Noncontributory VEAP	.026 (.053)	Services	1.05 (.394)
Mini GI Bill	.108 (.087)	Government	-.339 (.173)
8K Plus 4 Bonus	-.012 (.071)	Manufacturing	-.019 (.299)
Maximum 8K Bonus	-.114 (.050)	High Quality Goal	.166 (.042)
Qualified Military Available	-.297 (.361)	1980 Vote	1.13 (.789)
		Standard Error of Regression	.167

Standard error is in parenthesis.

TABLE 11

FIXED EFFECTS MODEL WESTERN REGION

Explanatory Variables	Estimates	Explanatory Variables	Estimates
Military Pay	.128 (.227)	Control Cell	.108 (.059)
Unemployment	.887 (.114)	Nat'l Adv	.039 (.016)
Recruiters Assigned	.257 (.188)	College Degrees	-2.55 (1.64)
Urban Pop	.401 (.279)	Income	6.77 (5.48)
Recruiter Exp	-.067 (.085)	% Black	-.664 (.573)
Local Advertising	.026 (.023)	% Hispanic	.579 (.323)
Second Qtr	.126 (.040)	Construction	.050 (.119)
Third Qtr	.164 (.040)	Trans and Util	-1.00 (.501)
Fourth Qtr	.317 (.048)	Retail Trade	2.50 (.779)
Army College Fund	.136 (.054)	Finance/Insurance	-1.21 (.708)
Noncontributory VEAP	-.180 (.096)	Services	.301 (.779)
Mini GI Bill	-.024 (.093)	Government	-.236 (.431)
8K Plus 4 Bonus	.037 (.068)	Manufacturing	-.184 (.218)
Maximum 8K Bonus	.086 (.072)	High Quality Goal	.045 (.041)
Qualified Military Available	.188 (.669)	1980 Vote	-5.65 (2.46)
		Standard Error of Regression	.187

Standard error is in parenthesis.

IV. ANALYSIS OF RESULTS

A. INTRODUCTION

Effective allocation of resources is accomplished through the analysis of the elasticities of the environmental factors generated from the use of regression techniques. The double log form of the models specified in this paper allows the coefficients of the parameters to be measured in terms of elasticities. [Ref. 4: p. 18]. The elasticity of each independent variable (environmental factors) indicates the percentage change in the mean of the dependent variable (high-quality male recruits) per unit increase from the mean of the respective independent variable given that all other independent variables are held constant at their means.

It is appropriate to remember that simple interpretation of the elasticities in the regression may be misleading [Ref. 14]. The problems of muliticollinearity with some of the variables makes it impossible to get truely isolated effects of each independent variable on the dependent variable. Still, it is appropriate to examine the elasticities to get an indication of each independent variable's influence on the dependent variable. It is a technique commonly accepted by econometricians modeling the all-volunteer force.

This chapter will examine each environmental factor's impact on the recruiting process. Identification of the most influential environmental factors is critical to the goal of effective resource allocation and cost effectiveness of recruiting programs. The influence of a variable will be measured by its elasticity and its level of significance to the model as defined by its standard error term. By specific identification of those influential variables which the Army has control of, the Army can tailor them in such a way to insure that the high-quality male goal is met. By identifying those factors which the Army has no control of, probable future states of the high-quality male recruit supply pool can be anticipated.

In this chapter, the elasticities of the independent variables will be analyzed through their comparison from different model specifications. It will be noted when there is a significant difference among the models' results with respect to an environmental factor's elasticity. The specific models are OLS, Instrumental Variable, Instrumental Variable with AR(1), and OLS with Fixed Effects. Discrepancies will be discussed and plausible explanations for their causes will be stated. An examination of

geographical variations will be conducted and the most significant environmental factors on a regional basis will be presented. Finally through the application of the Chow test, analysis of parametric consistency will be discussed.

B. ECONOMIC FACTORS

The elasticities of the economic factors were estimated from all four enlistment supply models. Small variances between the models in the elasticities of most of these variables were discovered with the inclusion of the competition effects variables in the models' specification. Sign consistency of the elasticities was present. The most significant economic factors were relative military pay and unemployment. Other significant determinants of the recruit supply were the number of employees in construction, transportation/public utilities, and government.

1. Relative Military Pay

The relative military pay variable was statistically significant in every model. A 1% increase in the relative military pay would cause the supply of high-quality male recruits to increase anywhere from .49% to .28% based on the model used. The coefficient of this variable decreased as the specification of the regression model became more sophisticated. The influence of the pay variable decreased when the competition effects were added. The value of this variable is about half of the lowest value of the earlier models mentioned. It is an illustration of the impact of omitting significant variables from the model. The expansion of the independent variable set caused an erosion of the importance of relative pay as some emphasis was shifted to family income and job market. This is consistent with congressional sources who have for the last several years restricted the increase or frozen E-1 pay in relation to all other pay increases given to all other ranks. The thought behind the freeze is that E-1 pay is not the primary cause in motivating high-quality males to enlist.

2. Unemployment

The estimated unemployment elasticity has a very strong effect on enlistment supply in every model. A decline of 1% in the unemployment rate causes a reduction of approximately .5% in the high-quality recruit supply. This unemployment finding highlights what Army manpower officials have long realized---the quality composition of entering recruits depends on the business cycle [Ref. 1: p. 281]. When unemployment is low, the Army falls short of the high-quality recruits and must make up this shortage by enlisting other than I-IIIA recruits. Because of no lateral entry into the upper enlisted rank, a below-average enlistment group makes for a below-average noncommissioned officer group a few years later.

3. Median Income

The median family income remained statistically significant throughout each model but its coefficient dropped from .826 to .386 as the model became more sophisticated. Interpretation of this parameter must be carefully scrutinized. If recruiting officials were to target high income neighborhoods for recruiting they would likely fail as much as if they had targeted low income neighborhoods for recruiting. The positive correlation between high-quality recruits and income is most likely a function of the supply pool increasing as the median income increases. At the recruiting battalion level, a composite of maybe sixty counties, the income variable is probably a good indicator of the number of qualified males in the area.

4. Job Market

A feature of this study, not used in any other known model, is the inclusion of specific job availability as defined by major industry grouping. Of the seven industries used as variables in the models, only construction, transportation/public utilities, and government were found to be consistently significant in the models. Of these three, only transportation/public utilities was found to have a negative influence on the high-quality recruit supply. It has the most negative influence (-.632 to -.268) of any variable in the model. Construction and government jobs had similar positive elasticities on the recruit supply. It was believed that job increases in the service sector would have a significant impact on recruiting but that is not the case at the high-quality level. An analysis of the job market indicates that there is more demand in the transportation/public utilities sector than any other sector for the type of individual that the Army is attempting to recruit.

C. SOCIODEMOGRAPHIC FACTORS

The elasticities of the sociodemograhic factors were estimated from all four enlistment models. The most significant sociodemographic variables found in common by these models were the percentage of Blacks and Hispanics in the general population, seasonal dummies, and urban population density. Multicollinearity was suspected of causing problems with a couple of the factors based on the mixed results obtained.

1. Qualified Military Available

Mixed results were noted from the qualified military available (QMA) variable. The expected results that high-quality enlistments increase with the size of the potential pool were not evident. The estimates on the QMA variable from the models specified

reflect a potential problem with multicollinearity. The fluctuation in the variable's statistical significance - significant in the OLS model but insignificant in the other models - and its changes in sign indicate the existence of multicollinearity. Because of the multicollinearity problem, the QMA variable does not reflect any inherent effect on high-quality enlistments but only a partial effect. An examination of the QMA variable's correlation with all other independent variables failed to identify the source of the co-linear problem. The correlation coefficient never exceeded .70. Most likely, QMA is a complicated function of several other independent variables.

2. Quarterly Dummies

The quarterly dummy variable confirmed the expectation that people are more likely to enlist in the summer period, July to September, than any other time of the year. This statistically significant variable indicates that after the fourth quarter of the fiscal year, the April to June period is the second most likely period for high-quality enlistments. The least likely time for enlistments is the first quarter, October to December period. These results are consistent with recruiters' observations that most seniors and high school graduates make their enlistment decision shortly after graduation [Ref. 1: p. 283].

3. Minorities

In all the estimates dealing with the principal minorities, Blacks and Hispanics, it was determined that areas with proportionately more minority youths in the population produced fewer high-quality enlistments. The negative effect for Blacks was found to be greater. For every 1% increase in the Black population, the percentage of high-quality enlistments dropped in a range from .078 to .183. The same percentage increase in the Hispanic population caused a drop from .068 to .109 in the high-quality enlistment rate.

4. College Degrees

The elasticities associated with the percentage of a recruiting battalion's population with college degrees showed a negative correlation with high-quality enlistments. This variable lost its significance when the instrumental variable AR(1) model was run. Again, the condition of multicollinearity is suspect but examination of the college degree variable's correlation with all the other independent variables fail to clearly identify a source. Although it is fair to assume that people with college degrees are highly unlikely to enlist, inference of a population susceptibility to enlistment given its education level (based on the percentage with college degrees) is tenuous based on these results.

5. Urban Area

The results of the enlistment supply models in this study indicate that high-quality enlistment supply is greater in urban areas. A 1% increase in the urban population increases enlistments from .021% to .053%. The lack of significance in the elasticities of this variable is probably a reflection of the domination of the number of recruiters assigned to a battalion. A likely determinant in recruiter assignment is the population density. The urban area population is important in the enlistment supply function but it indirectly contributes to the high-quality enlistment model through its use by manpower officials in determining the number of recruiters assigned to a battalion.

6. Republican Vote

The Republican vote variable failed to measure suspected differences in conservative or promilitary opinions across regions. The lack of a consistent positive sign in the vote elasticity might suggest that the enlistment decision isn't a clear indicator of a conservative viewpoint on part of the enlistee or the region he comes from. More likely, stronger incentives (economic, social, etc.) determine the likelihood of enlistment.

D. RECRUITING RESOURCES

A correct specification of the enlistment supply model is critical for proper interpretation of the recruiting resources' elasticities. The technique of allocation of recruiting resources across recruiting districts may cause them to be lagged endogenous variables [Ref. 1: p. 282]. In order to properly measure their effectiveness in determining enlistment supply, only the results from the fixed effects model applies. The most significant variables in determining enlistment supply are the number of recruiters assigned and national advertising impressions.

1. Recruiters Assigned

The elasticity of recruiters assigned dropped from a high of .556 to .150 with the introduction of the fixed effects model. This variable maintained a statistically significant positive correlation with high-quality enlistment. For every 1% increase in recruiters added to a recruiting district the number of high-quality enlistments increased by a minimum of .15%.

2. Recruiter Experience

There was no significant relationship between the number of recruiters with more than nine months recruiting service and the number of high-quality enlistments. Eagerness of newly assigned recruiters to do well may have offset any advantage experienced recruiters may have had. An interesting study might be an examination to see if the most qualified recruiters (based on enlistment evaluation report scores) have a significant impact on recruiting.

3. National Advertising Impressions

The estimated effectiveness of national advertising remained fairly constant in all four models. Although the variable was statistically significant, its impact is considerably less than most of the other variables. In the fixed effects model, a 1% increase in advertising reflected in only a .054% increase in enlistments. Previous studies of Army advertising effects have obtained widely divergent results [Ref. 1: p. 287]. Brown found a statistically significant, negative impact on national advertising expenditures on high-quality enlistments [Ref. 4: p. 32]. Most if not all manpower officials would agree that advertising is important for enlistment. The problem is in measuring how advertising affects the 17-21 year-old group. Results on this variable will probably remain divergent until a more accurate technique is used to determine advertising influence.

4. Local Advertising Expenditures

In the fixed effects model, local advertising had a statistically significant negative impact on enlistment. A 1% increase in advertising dollars caused a .017% decrease in high-quality enlistments. The ways in which local advertising dollars are spent are at the discretion of the local battalion commanders. The underlying conclusion of this variable's elasticity is that most recruiting commanders do not spend their dollars effectively.

E. ENLISTMENT POLICIES

The elasticities of Army enlistment policies, postservice education benefits, and enlistment bonuses offered were estimated in all four models. Dummy variables were used to analyze the effectiveness of these policies with one another. The Army College Fund and large bonuses for 3-year enlistments clearly proved to be the most effective. Recruiting goals' elasticities were examined to check if the appropriate quotas for high-quality enlistments were correctly specified to insure that the enlistments remained supply-constrained.

1. **Postservice Education Benefits**

The results from this variable highlight the importance of postservice education benefits in recruiting high-quality youth. During the fiscal year 1981 education benefits test, Army recruiting districts offered four different packages, a volunteer educational assistance program with additional government contribution (SuperVEAP), a VEAP program with further enhanced benefits (Army College Fund), a VEAP program without the contributions required of participants in the basic program (noncontributory VEAP), and a less generous version of the GI Bill (mini-GI Bill). A set of dummy variables was included in the enlistment models to represent these variations in education benefits.

Compared with the SuperVEAP, which is the base group in the models, the Army College Fund is estimated to increase the supply of high-quality enlistments by a minimum of 20%. The other postservice education benefits were undistinguishable in comparison with SuperVEAP. Clearly, the Army College Fund is the most attractive education benefits program the Army can offer to high-quality males.

2. **Enlistment Bonuses**

There were three treatments in the Enlistment Bonus Test. The first was a control cell where the existing schedule of enlistment bonuses - from $1500 to $5000 depending on the military occupation chosen - was offered. The second treatment raised the bonus amounts so that they varied from $2500 to $8000. The final cell offered the higher schedule and $4000 bonuses for 3-year enlistments. In all the other cells, bonuses were only available for individuals enlisting for 4 years.

There was no substantial effect on enlistment supply when 4-year bonuses were raised, but when the 3-year bonus is offered there is an increase in high-quality enlistments. An elasticity of .049 on the 3-year bonus indicates a positive significant relationship with enlisting. For high-quality males whom have the goal of attending college, 3 years would appear to be the limit at which they would wait to enter.

3. **High-Quality Goal**

The recruiting goal has a positive significant impact on enlistment. The positive coefficient assigned to this variable indicates proper determination of quotas set. Negative elasticities would reflect too low of a threshold implying that some high-quality enlistments were demand-constrained instead of supply-constrained. Only supply-constrained observations can be used to estimate enlistment supply of high-quality recruits. If demand-constrained observations were used, the resulting estimate of the elasticity with respect to the independent variables would be biased downwards.

F. COMPETITION EFFECTS

Competition effects were measured only in the instrumental variable models because the inclusion of them in the other models would cause biased coefficients. The results show that there is competition for a recruiter's time and effort and that the Army is the last choice of most high-quality males.

1. Other DOD I-IIIA

The number of high-quality recruits enlisted by the other armed services has a statistically significant, negative impact on the Army's ability to attract high-quality recruits. An elasticity of -.044 reflects the Army's disadvantage in recruiting high-quality males. The elasticities in the instrumental variable models indicate a drop in the Army enlistment supply for every time additional youths are recruited by the other services.

2. Other Army Recruits

The estimates of the influence of other Army recruits - other than I-IIIA males - reflect no negative impact on high-quality recruiting. This positive correlation suggests that when the Army recruits, it recruits in all categories. There is also a chance that in order to insure quotas are met, recruiters delay signing some individuals for a later month when the available supply is lower than anticipated.

G. GEOGRAPHICAL VARIATION

A difficult task for manpower officials is allocating recruiting resources on a regional basis based on analysis conducted at the national level. Some pragmatists argue that regional analysis is required for cost effective resource allocation. The influence of the environmental factors that affect high-quality enlistments differ from region to region. These differences highlight the importance of determining specific resources at the regional level instead of a nation-wide issuance of similiar resources to each region.

Because of politics and national interest, not all resources can be parceled out on a regional level. It would be foolish of the Army to offer higher enlistment bonuses in the Southeast than in the Southwest. It would not be pragmatic, for example, for the Army not to actively recruit in Maine because it is not cost effective. Besides the Maine congressional delegation protesting such a policy, the Army prides itself in being the ground fighting force for all the United States.

While resources like postservice education benefits, enlistment bonuses, and, to some extent, recruiter assignments are immune to geographic variation in determining

resource allocation, many other resources can effectively, through careful dissemination, improve the Army's ability to enlist large number of high-quality males. It is useful to get a feel for the extent of regional variation in the most important of these environmental factors that characterize local labor market conditions and regional demographics and have a significant influence on the allocation of resources. Regional averages of civilian earnings, unemployment, urban population, percentage of population with college degrees, and median family income are presented in Appendix C.

During the 1981-1984 period unemployment was highest in the Midwest and lowest in the Southwest. The other three regions were within one percentage point of each other. Civilian earnings showed substantial variance during this period. Production workers in the Southeast earned over $100 less a week than their counterparts in the Midwest, who had the highest average earnings. This pattern remains the same for median family income. The Southeast is the least urbanized region and the West is the most educated.

In the remainder of this section, analysis of each region's fixed effects model will be conducted with interpretation of the elasticities of key environmental factors peculiar to the region that impact on the enlistment supply. How these elasticities could be used in allocating recruiting resources is discussed.

1. **Northeast**

Similiar to all other regions, the unemployment rate is the most critical determinant of the recruit supply. Relative military pay, recruiters assigned, and the urbanization percentage were the other significant environmental factors that showed a positive impact with enlistment. Minorities had significant negative influences. Job market segmentation in the Notheast was evenly split with the number of people employed in the service sector having the most positive influence and the number of people employed in retail trade having the most negative influence.

Based on the elasticities computed in the Northeast model, recruiters should target the suburbs for enlistments. The positive urban coefficient and negative minority coefficients clearly indicate that. The urban elasticity indicates that the enlistments come from built-up areas but the negative elasticity associated with Blacks and Hispanics, who predominately live in the inner cities, reflect little success in recruiting there. The positive Republican vote (large percentage is white) gives another indication of this relationship because most major northeastern cities are Democratic while the

suburbs are mostly Republican. The negative local advertising coefficient means an advertising pitch in the inner cities is not drawing qualified Blacks and Hispanics into the service.

2. **Southeast**

The Southeast model offers several conflicting points. While the relative pay coefficient, .241, is positive, it is lower than either the Northeast or Southwest where civilian earnings are higher. Because Southeastern workers earn the lowest pay, intuitively you would expect that the relative military pay variable would have the most significant positive impact of these three regions, which it does not. Perhaps specifying production workers' earnings for pay comparison is inappropriate.

The only region where the black population elasticity, 1.44, has a positive impact on recruiting is in the Southeast. Perhaps Blacks perceive the Army as a better opportunity for advancement than what civilian employment offers in the South. The use of more black recruiters in the Southeast may let the Army take advantage of this situation.

Strangely, the number of recruiters assigned did not have a significant impact on recruiting but advertising did. In the Southeast, the electronic and print media can effectively do much of what other recruiters do around the country. It is interesting to examine what these results imply about cost effectiveness of advertising and recruiters. Using fiscal year 1983 dollars, a 1% increase in the recruiter force would cost about $1.75 million, while a 1% increase in all advertising would increase recruiting costs by approximately $400,000 [Ref. 1: p. 287]. In the Southeast, by supplanting some recruiters with more advertising, more high-quality enlistments can be obtained at a lower cost.

3. **Southwest**

The critical environmental factors in the Southwest that positively influence enlistments are relative military pay, unemployment, assigned recruiters, and urban population percentage. The minorities have a negative influence on enlistments. Within the Southwestern job market, the strongest positive correlation with attracting high-quality males is employment in the service sector while government employment (excluding military) has the strongest negative correlation

The strongest among all the regions, the urban population percentage coefficient, .410, reveals that most high-quality enlistments come from cities. Because of the great distances recruiters would have to travel to cover a entire recruiting

district, it is not surprising that they would primarily focus their efforts to recruit in the city. The strong positive elasticity associated with employment in the service sector suggests the Army is viewed quite favorably when compared to the service industry. In the Southwest at least, the Army is defeating McDonalds in competition for the high-quality male.

In this region, there is no obvious policy alteration plan required to increase the number of enlistments. With the exception of increasing military pay (which always raises enlistment) there is no cost effective alternative. Most of the influential factors here are not controlled by the Army. With the use of accurate economic forecasts in this region, the Army might be able to anticipate windfalls or shortfalls in the recruit supply and adjust accordingly.

4. Midwest

Unemployment dominated the Army's influence in recruiting high-quality enlistments in the Midwest during 1981-1984. In fact, during this period, the Midwest replaced the Southeast as the dominant per capita supplier of recruits to the Army [Ref. 4: p. 17]. The unemployment elasticity, .923, was so influential in determining enlistments that the relative pay variable was found to be statistically insignificant. The loss of jobs in the Midwest is reflected in the negative elasticities associated with employment in transportation/public utilities, retail trade, and manufacturing. As the number of employed shrunk in these industries, Army enlistments rose.

From analysis of the 1981-1984 period, the Army's ability to recruit high-quality males in the Midwest goes as the economy goes. This traditional view is the most valid in the Midwest. With an upswing in the economy, manpower officials will have to look for other ways to entice qualified men into the service. The high elasticity of recruiters assigned, .589, is due to the artificially high number of enlistments caused mostly by unemployment. Only in the Midwest did all the postservice education benefits show positive influence. This might relate to the Midwest having the second lowest percentage of college degrees in the nation. Affordability of college is more difficult here than in most other regions. Promotion by recruiters and advertising of college money earned while serving in the Army may be the most effective avenue Army recruiters can take to maintain enlistments in the Midwest.

5. West

In accordance with the elasticities generated for the environmental factors in the West, the Army has a difficult goal to attain. The only clear opportunity to enlist

high-quality males in the West is during a sluggish economy. The second highest unemployment elasticity, .887, is in the West. Four out of the seven industries show a negative relationship with enlistment. The loss of jobs in transportation/public utilities, real estate, government, and manufacturing will increase high-quality enlistments. An elasticity of .128 makes the relative pay less effective than in all but one of the other regions. The most positive discovery in the West is a remarkably high positive elasticity for Hispanics, .556.

Like the Midwest, the fixed effects model for the West supports the traditional outlook on recruiting - recruiting goes the opposite of the economy. Both local and national advertising have positive impacts on recruiting as did the Army College Fund. To offset the growth in the economy, additional funds in advertising and postservice education benefits are needed in the West to recruit qualified males.

H. STRUCTURAL ANALYSIS

The final analysis of the regression coefficients is a test for structural change or stability of the elasticities. Stability can be important if the model's results are to be used for long range forecasting. The parameters in this study are suspected of instability primarily because of the time period in which the data was collected. During the time period 1981-1984, two major events that could affect enlistments occured. First, the end of an economic recession in January 1982 could cause instability the economic-related factors instability. Second, in June 1983 a new USAREC commander was appointed whose different leadership qualities and management style imposed higher motivation in Army recruiters.

TABLE 12
CHOW TEST

Breakpoint	Computed F	$F_{(k,n+m-2k)}$	Results
January 82	9.12	1.60	Reject H_0
June 83	7.53	1.60	Reject H_0

Chow tests are a special form of F-tests in which the stability of the regression coefficients over two subperiods of the data set are tested. The Chow tests preformed

in this study are summarized in Table 12. This is normally done by running the same regression for the whole period, then running the same regression for the two subperiods, and comparing the sums of squared residuals (SSR). The breakpoint for the subperiods is a subjective determination on part of the researcher. We have already discussed the probable breakpoints for this model. An F-test for the constraint that the two sets of coefficients are equal (i.e., stable) can be computed from the SSR as follows: [Ref. 13: p. 83]

$$\frac{(SSR_{all} - SSR_1 - SSR_2)/k}{(SSR_1 + SSR_2)(n+m-2k)} \sim F_{(k,n+m-2k)} \qquad \text{(eqn 4.1)}$$

Here k represents the number of restricted coefficients, n the number of observations in the first period, and m the number of observations in the second period. The null hypothesis, H_0, tests to see if the coefficients are equal. The computed F above is compared to the $F_{(k,n+m-2k)}$ statistic. If the computed tabled F is less than $F_{(k,n+m-2k)}$, accept H_0 that the coefficients are stable.

From analysis using the most sophisticated model in the study, Instrumental Variable with AR(1), instability for each breakpoint was determined. In general, the larger the sample size, the more likely we are to reject the null hypothesis as stated [Ref. 11: p. 422]. To overcome this difficulty, Kmenta suggests to change the level of significance with sample size. In particular, the null hypothesis, H_0, that the coefficients are stable, is accepted if:

$$F < \frac{n-k}{r}(n^{r/n} - 1). \qquad \text{(eqn 4.2)}$$

where F is the calculated value of the F statistics, r is the number of restrictions, and (n-k) is the number of degrees of freedom corresponding to the unrestricted error sum of squares [Ref. 11: p. 422].

Using this method to allow for correction of sample size bias, the null hypothesis of coefficient stability is accepted (See Table 13). This result permits the use of this model for long range forecasting which is critical in the budgetary process. The recruiting budget is submitted two years prior to the year of implementation which

TABLE 13
KMENTA SAMPLE SIZE CORRECTION

Computed F	$F_{(30,2580)}$	Results
8.14	1.60	Accept H_0

requires an accurate assessment of how environmental factors influence recruiting over time.

I. CONCLUSIONS

The four models specified in this study provided consistent elasticities for many environmental factors suspected of influencing recruiting. Relative pay, unemployment, advertising, urban population, median income, minorities, quarterly dummies, and employment in transportation/public utilities were the most significant factors affecting enlistment.

By running the fixed effects models at regional level differences were noted in several environmental factors. With this knowledge, manpower officials can target regions with different mixes of resources to insure high-quality enlistments.

Coefficient stability was determined in the study. Stable structure of the coefficients permits long range forecasting of the effects of the environmental factors in enlistments which are critical to the budgetary process.

V. SUMMARY AND CONCLUSIONS

The ability to enlist qualified young men into the Army is critical to the maintenance of peace by the United States in today's world. With the advent of sophisticated and lethal weapon systems, the challenge to operate and maintain them exceeds the mental capacity of many young adults. The Army has identified, through a series of tests, that individuals categorized as I-IIIA's are capable of meeting the challenges of today's technology. In order to recruit these qualified young men, the Army must determine what environmental factors influence enlistment and seek to manipulate them to insure a proper flow of high-quality recruits into the service. In addition to insurance of quantities of skilled recruits, the Army seeks to become more cost effective in recruiting to offset potential cutbacks in the recruiting budget.

The objective in this study was to determine which environmental factors influence recruiting. Identification of these factors will allow the determination of the best mix of resources to meet the Army's recruiting mission, provide warnings of downturns in recruiting potential and identify effective compensatory programs. Econometric modeling using regression analysis was used to estimate the determinants of supply.

Previous work done by other econometricans was mentioned and ideas borrowed. The uniqueness of this study is the effort made to further explain the relationship of the nation's economy to recruiting through an expansion of the explanatory variable set highlighted by the inclusion of specific employment opportunities available in the civilian sector. Hopefully, model specification error was reduced because of the inclusion of these variables.

Four models were estimated. The question of which model, Ordinary Least Squares, Instrumental Variable Estimation, Instrumental Variable Estimation with AR(1), or Fixed Effects, is best, is not appropriate. The fact that a set of supply determinants, given by each model, are different indicates the degree of risk. The more the models agree, the lower the risk. On the other hand, the more the models disagree, higher the risk and the possible need of policy change to reduce it.

Each model has its own capabilities, disadvantages, and uses. Each model was designed under different assumptions of the pooled data which included forty-eight

monthly observations per variable for fifty-five recruiting battalions. Consideration of heteoskedasticity, autocorrelation, measurement errors in the independent variable, covariance, and coefficient stability was addressed.

The results of this study showed that, in general, the environmental factors that positively influenced high-quality enlistments were: relative military pay, unemployment, recruiters assigned, advertising, the Army College Fund, and median income. In general, the most significant environmental factors that adversly affect recruiting were: the percentage of Blacks and Hispanics in the population, college degrees, implementation of the Noncontributory VEAP Program, and high-quality enlistments by the other services.

Inclusion of the job sector employment variables provided limited additional information. The only industry to have a consistent influence on enlistment was the transportation/public utilities sector which demonstrated an adverse effect on recruiting.

Finally, limitations on even the most sophisticated models specified in this study must be recognized. Such models, based on past data, generally are excellent for describing the past and also the near future if environmental factors remain stable. In economics the past does not necessarily accurately foreshadow the future. This point is critical when one realizes that these enlistment models (like all others) are developed largely on economic data. Further, an econometric model cannot predict such important incommensurables as the politics of Congress or changes in the attitudes of people towards service in the military.

APPENDIX A
USAREC ORGANIZATION

Northeast Brigade

Albany, NY
Baltimore, MD
Boston, MA
Concord, NH
Harrisburg, PA
New Haven, CT
Long Island, NY
Newburgh, NY
Ft. Monmouth, NJ
Philadelphia, PA
Pittsburgh, PA
Syracuse, NY

Midwest Brigade

Chicago, IL
Cincinnati, OH
Cleveland, OH
Columbus, OH
Des Moines, IA
Detroit, MI
Indianapolis, IN
Lansing, MI
Milwaukee, WI
Minneapolis, MN
Omaha, NB
Peoria, IL
St. Louis, MO

Southeast Brigade

Atlanta, GA
Beckley, WV
Charlotte, NC
Columbia, SC
Jacksonville, FL
Louisville, KY
Miami, FL
Montgomery, AL
Nashville, TN
Raleigh, NC
Richmond, VA

Southwest Brigade

Albuquerque, NM
Dallas, TX
Denver, CO
Houston, TX
Jackson, MS
Kansas City, MO
Little Rock, AR
New Orleans, LA
Oklahoma City, OK
San Antonio, TX

West Brigade

San Francisco, CA
Honolulu, HI
Los Angeles, CA
Phoenix, AZ
Portland, OR
Sacramento, CA
Salt Lake City, UT
Santa Ana, CA
Seattle, WA

APPENDIX B
MEAN CHARACTERISTICS OF DATA SET

Variable	Mean
Civilian Pay (per week)	345.0
Advertising Impressions (000's)	1301.0
QMA % of Population	70.6
Black % of Population	11.1
Hispanic % of Population	6.9
Unemployment Rate	8.6
Recruiters Assigned	87.8
Recruiters Experience	67.6
Local Advertising Expenditures (00's)	64.3
Republican Vote %	51.9
College Degrees %	15.9
Median Income (000's)	16.9
Urban % of Population	70.7
Employees in Construction (000's)	79.1
Employees in Trans/PU (000's)	97.9
Employees in Retail (000's)	386.5
Employees in Finance (000's)	104.1
Employees in Services (000's)	355.1
Employees in Government (000's)	103.8
Employees in Manufacturing (000's)	356.1
High Quality Goal	71.9
DOD I-IIIA Recruits	179.0
Other Army Recruits	127.6
Army I-IIIA Recruits	78.5

APPENDIX C
REGIONAL VARIATION STATISTICS

Variable	Northeast	Southeast	Southwest	Midwest	West
Earnings	331	290	336	395	368
College %	17.5	13.2	15.7	14.6	18.9
Income (000's)	17.7	14.7	15.8	18.1	17.8
Urban %	74.6	59.2	70.8	69.3	81.6
Unemployment	7.9	8.7	7.5	9.9	8.7
Black %	9.7	18.4	13.8	8.4	4.3
Hispanic %	4.2	7.3	12.4	1.8	11.2
Enlistees	80.3	75.6	56.9	98.9	73.1
QMA (000's)	83.2	43.9	66.9	81.9	74.2

LIST OF REFERENCES

1. Daula, T. and Smith, D., "Estimating Enlistment Models For the U.S. Army, " *Research in Labor Economics*, v. 7, pp. 261-309.

2. Toomepuu, J., *Education and Military Manpower Requirements*, paper presented at the Annual Meeting of the Council of Chief State School Officers, 15 November 1986.

3. Gilroy, Curtis L., *Army Manpower Economics*, Westview Press Inc., 1986.

4. Brown, C., National Bureau of Economic Research Report 1261, *Military Enlistments: What Can We Learn From Geographic Variation?*, C. Brown, January 1984.

5. United States Army Recruiting Command Information Paper, Subject: Forecasting of Army Recruiting, 23 July 1984.

6. General Ono Interview, Cable News Network March 1983, *Why Young People are Entering the Army Today.*

7. Ash, Colin and others, "Enlistments in the All-Volunteer Force: A Military Personnel Supply Model and Its Forecasts," *American Economic Review*, pp. 145-155, March 1983.

8. Greenston, P. and Goldberg, L., *Economic Analysis of Army Enlistments Policy Implication*, paper presented at Conference on Army Manpower Economics, Williamsburg, Virginia, 5 December 1984.

9. Wharton Center for Applied Research Final Report July 1986, *The FY 1984 Advertising Mix Test.*

10. Dertouszos J., Rand Report R-3065-ML, *Recruiter Incentive and Enlistment Supply*, May 1985.

11. Kmenta, Jan., *Elements of Econometrics*, Macmillan Inc., 1986.

12. Cochrane, D. and Orcutt, G., "Application of Least Squares Regression to Relationships Containing Autocorrelated Error Terms," *Journal of the American Statistical Association*, v. 44, pp. 32-61.

13. Hall, B., *Time Series Processor User's Manual*, TSP International, 1983.

14. Hoaglin, D.C., and others, *Exploring Data Tables, Trends, and Shapes*, John Wiley & Sons, 1985.

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Thesis
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